

Vivek Jayaraman

Senior Group Leader & Head of Mechanistic Cognitive Neuroscience
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Education/Training

Aug 1990 to May 1994	Indian Institute of Technology (IIT) <i>Bachelor of Technology (Aerospace Engineering)</i>	Bombay, India
Aug 1994 to Aug 1996	University of Florida <i>Master of Science (Aerospace Engineering); Advisor: Wei Shyy</i>	Gainesville, FL
1998 to 2001	Brandeis University <i>Graduate courses in Neuroscience, Cognitive Science, AI</i>	Waltham, MA
2001 to 2006	California Institute of Technology (Caltech) <i>Ph.D. (degree awarded: May 2007)</i> <i>Computation & Neural Systems; Advisor: Gilles Laurent</i>	Pasadena, CA

Positions

April 1992 to Aug 1992	Indian Institute of Science , Bangalore, India <i>Summer Trainee, Hypersonic Wind Tunnel Lab (Aerospace Engineering)</i>
April 1993 to Aug 1993	National Aerospace Laboratories , Bangalore, India <i>Practical Trainee, Computational Fluid Dynamics Group</i>
Sept 1996 to Dec 1998	PTC (makers of Pro/Engineer & Pro/Mechanica), Waltham, MA <i>Software Engineer (Engineering Modeling)</i>
Jan 1999 to Aug 2001	MathWorks (makers of MATLAB & Simulink), Natick, MA <i>Software Engineer (Control Design Automation)</i>
Nov 2006 to Dec 2009	Janelia Farm Research Campus, HHMI , Ashburn, VA <i>Janelia Farm Fellow (Lab Head)</i>
Jan 2010 to Feb 2018	Janelia Research Campus, HHMI , Ashburn, VA <i>Group Leader</i>
Mar 2018 to present	Janelia Research Campus, HHMI, Ashburn, VA <i>Senior Group Leader & Head of Mechanistic Cognitive Neuroscience</i>

Honors

2001-2002	Charles Lee Powell Fellowship , California Institute of Technology
2002-2003; 2005	Sloan-Swartz Pre-doctoral Fellowship for Theoretical Neuroscience , California Institute of Technology
2017	Society for Neuroscience Young Investigator Award

Peer-reviewed primary publications

* Equal contributors

- Stopfer M*, Jayaraman V*, and Laurent G (2003). Intensity versus identity coding in an olfactory system. *Neuron*, 39.
- Broome BD*, Jayaraman V*, and Laurent G (2006). Encoding and decoding of overlapping odor sequences. *Neuron*, 51.
- Jayaraman V and Laurent G (2007). Evaluating a genetically encoded optical sensor of neural activity using electrophysiology in intact adult fruit flies. *Frontiers in Neural Circuits*.
- Tian L, Hires SA, Mao T, Huber D, Chiappe ME, Chalasani SH, Akerboom J, McKinney SA, Schreiter ER, Bargmann CI, **Jayaraman V**, Svoboda K, and Looger LL (2009). Imaging neural activity in worms, flies and mice with improved genetically encoded calcium indicators. *Nature Methods*, 6(12).
- Seelig JD*, Chiappe ME*, Lott GK*, Dutta A, Osborne J, Reiser MB, and Jayaraman V (2010). Two-photon calcium imaging from head-fixed *Drosophila* during optomotor walking behavior. *Nature Methods*, 7(7).
- Chiappe ME, Seelig JD, Reiser MB, and Jayaraman V (2010). Walking modulates speed sensitivity in *Drosophila* motion vision. *Current Biology*, 20(16).
- Akerboom J, Chen TW, Wardill TJ, Tian L, Marvin JS, Mutlu S, Calderón NC, Esposti F, Borghuis BG, Sun XR, Gordus A, Orger MB, Portugues R, Engert F, Macklin JJ, Filosa A, Aggarwal A, Kerr RA, Takagi R, Kracun S, Shigetomi E, Khakh BS, Baier H, Lagnado L, Wang SS, Bargmann CI, Kimmel BE, **Jayaraman V**, Svoboda K, Kim DS, Schreiter ER, Looger LL (2012). Optimization of a GCaMP calcium indicator for neural activity imaging. *Journal of Neuroscience*, 32(40).
- Chen TW, Wardill TJ, Sun Y, Pulver SR, Renninger SL, Baohan A, Schreiter ER, Kerr RA, Orger MB, **Jayaraman V**, Looger LL, Svoboda K, Kim DS (2013). Ultrasensitive fluorescent proteins for imaging neural activity. *Nature*, 499(7458).
- Wardill TJ, Chen TW, Schreiter ER, Hasseman JP, Tsegaye G, Fosque BF, Behnam R, Shields BC, Ramirez M, Kimmel BE, Kerr RA, **Jayaraman V**, Looger LL, Svoboda K, Kim DS (2013). A neuron-based screening platform for optimizing genetically-encoded calcium indicators. *PLoS One*, 8(10):e77728.
- Seelig JD and Jayaraman V (2013). Feature detection and orientation tuning in the *Drosophila* central complex. *Nature*, 503(7475).
- Klapoetke NC, Murata Y, Kim SS, Pulver SR, Birdsey-Benson A, Cho YK, Morimoto TK, Chuong AS, Carpenter EJ, Tian Z, Wang J, Xie Y, Yan Z, Zhang Y, Chow BY, Surek B, Melkonian M, **Jayaraman V**, Constantine-Paton M, Wong GK, Boyden ES. Independent optical excitation of distinct neural populations (2014). *Nature Methods*, 11(3).
- Fosque BF*, Sun Y*, Dana H*, Yang CT, Ohshima T, Tadross MR, Patel R, Zlatić M, Kim DS, Ahrens MB, **Jayaraman V**, Looger LL, Schreiter ER. Labeling of active neural circuits in vivo with designed calcium integrators (2015). *Science*, 347(6223).
- Seelig JD and Jayaraman V (2015). Neural dynamics for landmark orientation and angular path integration. *Nature*, 521(7551).
- Schulze A*, Gomez-Marin A*, Rajendran VG, Lott G, Musy M, Ahammad P, Deogade A, Sharpe J, Riedel J, Jarriault D, Trautman ET, Werner C, Venkadesan M, Druckmann S, **Jayaraman V**, Louis M. (2015). Dynamical feature extraction at the sensory periphery guides chemotaxis. *eLife*. 4:e06694.
- Zhou C, Franconville R, Vaughan AG, Robinett CC, **Jayaraman V**, Baker BS (2015). Central neural circuitry mediating courtship song perception in male *Drosophila*. *eLife*. 4:e08477.

- Dana H, Mohar B, Sun Y, Narayan S, Gordus A, Hasseman JP, Tsegaye G, Holt GT, Hu A, Walpita D, Patel R, Macklin JJ, Bargmann CI, Ahrens MB, Schreiter ER, **Jayaraman V**, Looger LL, Svoboda K, Kim DS (2016). Sensitive red protein calcium indicators for imaging neural activity. *eLife*. 5:e12727.
- Kim SS*, Rouault H*, Druckmann S, **Jayaraman V** (2017). Ring attractor dynamics in the *Drosophila* central brain. *Science*, eaal4835.
- Turner-Evans D*, Wegener S*, Rouault H, Franconville R, Seelig J, Wolff T, Druckmann S, Jayaraman V (2017). Angular velocity integration in a fly heading circuit. *eLife*, 6:e23496.
- Sun Y, Nern A, Franconville R, Dana H, Schreiter E, Looger L, Svoboda K, Kim D, Hermundstad A, **Jayaraman V** (2017). Neural signatures of dynamic stimulus selection in *Drosophila*. *Nature Neuroscience*, 30:(181).
- Franconville R, Beron C, **Jayaraman V** (2018). Building a functional connectome of the *Drosophila* central complex. *eLife*, 7:e37017.
- Dana H*, Sun Y*, Mohar B*, Hulse BK*, Kerlin AM, Hasseman JP, Tsegaye G, Tsang A, Wong A, Patel R, Macklin JJ, Chen Y, Konnerth A, **Jayaraman V**, Looger LL, Schreiter ER, Svoboda K, Kim DS (2019). High-performance calcium sensors for imaging activity in neuronal populations and microcompartments. *Nature Methods*.
- Haberkern H, Basnak MA, Ahanonu B, Schauder D, Cohen JD, Bolstad M, Bruns C, **Jayaraman V** (2019). Visually guided behavior and optogenetically induced learning in head-fixed flies exploring a virtual landscape. *Current Biology*, 29(10).
- Kim SS, Hermundstad AM, Romani S, Abbott LF, **Jayaraman V** (2019). Generation of stable heading representations in diverse visual scenes. *Nature*, 576 (7785).

Other publications (reviews, previews, book chapters)

- **Jayaraman V** and Laurent G (2008). Circuit dynamics and neural coding in the locust olfactory system. In L.R. Squire (Ed.), *The New Encyclopedia of Neuroscience*, Elsevier Science, Oxford, UK.
- Huston S and Jayaraman V (2011). Studying sensorimotor integration in insects. *Current Opinions in Neurobiology*, 21(4).
- Seelig JD and **Jayaraman V** (2011). Studying sensorimotor processing with physiology in behaving *Drosophila*. *International Review of Neurobiology*, 99.
- Chiappe ME and **Jayaraman V** (2012). Performing electrophysiology and two-photon calcium imaging in the adult *Drosophila* central brain during walking behavior. In *Genetically Encoded Functional Indicators, Neuromethods*, vol. 72, Jean-René Martin (ed.).
- Jayaraman V (2012). Visual neuroscience: a moving story of neuromodulation. *Current Biology*, 22(24).
- Kim SS, Franconville R, Turner-Evans D, **Jayaraman V** (2015). Optogenetics in *Drosophila melanogaster*. In Adam D. Douglass (Ed.), *New Techniques in Systems Neuroscience*, Springer, 147-176.
- Haberkern H and **Jayaraman V** (2016). Studying small brains to understand the building blocks of cognition. *Current Opinions in Neurobiology*, 37.
- Turner-Evans DB and **Jayaraman V** (2016). The insect central complex. *Current Biology*, 26(11).
- Hulse BK, **Jayaraman V** (2019). Busted! A Dope Ring with Activity Clocked at Dawn and Dusk. *Neuron*, 102.
- Hulse BK, **Jayaraman V** (2019). Mechanisms Underlying the Neural Computation of Head Direction. *Annual Review of Neuroscience*, 43.

Conference presentations/Invited talks

- *International Neuropsychology Symposium (INS) Meeting*, Mondello, Sicily, 2003
- *Imaging Neurons and Neural Activity: New Methods, New Results*, Cold Spring Harbor Laboratory, 2007
- *Using in vivo physiology to understand neural circuits in genetic model organisms*, JFRC, HHMI, 2008
- *Mid-Atlantic MEMS Alliance Technology Pull*, Johns Hopkins University Applied Physics Laboratory, 2008
- *Physiology Seminar*. Yale University, New Haven, 2009
- *Max Planck Institutes Joint Neuro Retreat*, Berlin, 2009
- *Max Planck Institute*, Heidelberg, 2009
- *Technical Challenges in Extracellular Electrophysiology*, JFRC, HHMI, 2009
- *Biology Seminar*. Case Western Reserve University, Cleveland, OH, 2010
- *Synaptic Integration & Plasticity Seminar*. NIH/NIDCD, Bethesda, MD, 2010
- *2010 Bangalore Maggot Meeting: Neural circuits to behavior*. National Center for Biological Sciences (NCBS), Bangalore, India, 2010
- *ESF-EMBO Symposium on Minibrains*. Sant Feliu de Guixols, Spain, 2010
- *Biological Imaging Lecture Series*. University of Wisconsin, Madison, WI, 2011
- *HHMI Science Meeting*, JFRC, HHMI, 2011
- *Neural Circuits of Decision-Making*, JFRC, HHMI, 2011
- *Genes to olfaction: 60 years in science*, National Center for Biological Sciences, Bengaluru, India, 2012
- *Promise and peril: genetic approaches for systems neuroscience revisited*, COSYNE workshop, Snowbird, UT, 2012
- *NERF Neurotechnology Symposium*, Leuven, Belgium, 2012
- *Stanford Institute for Neuro-Innovation & Translational Neurosciences Seminar*, Stanford University, 2012
- *Vision Symposium*, International Society for Neuroethology meeting, College Park, MD, 2012
- *NCAB Seminar*, National Capital Area Branch of the American Association for Laboratory Animal Science, National Harbor, MD, 2012
- *Departmental Seminar*, Hampton University, VA, 2012
- *Genes, Circuits and the Development of Behavior*. Tata Institute of Fundamental Research, Mumbai, India, 2013
- *Department of Biosciences & Bioengineering Seminar*. Indian Institute of Technology, Bombay, Mumbai, India, 2013
- *Basel Seminars in Neuroscience*, Friedrich Miescher Institute for Biomedical Research, Basel, Switzerland, 2013
- *Methods of System Identification for Studying Information Processing in Sensory Systems*, CNS Workshop, Paris, 2013.
- *HHMI Science Meeting*, JRC, HHMI, 2013
- *FENS Brain Conference on Controlling Neurons, Circuits and Behavior*. Rungstedgaard, Denmark, 2014
- *Center for Brain Science Brownbag Seminar*, Harvard University, Cambridge, MA, 2014
- *Action selection: the role of the insect central complex*, International Society for Neuroethology meeting, Sapporo, Japan, 2014
- *ESF-EMBO Symposium on Minibrains*. Sant Feliu de Guixols, Spain, 2014
- *Columbia Workshop on Brain Circuits, Memory and Computation*, Columbia University, New York City, NY, 2015
- *Interdisciplinary Program in Neuroscience Seminar*, Georgetown University, Washington, DC, 2014
- *Student-Organized Seminar*, Center for Neuroscience, University of California, Davis, CA, 2015
- *Institute of Neuroscience Seminar*, University of Oregon, Eugene, OR, 2015

- *Gatsby Tri-Centers Meeting*, Columbia University, New York City, NY, 2015
- *Swartz Foundation Annual Meeting*, Janelia Research Campus, Ashburn, VA, 2015
- *EMBO-Kavli Meeting on Neural Circuits and Behavior of Drosophila*, Kolymbari, Crete, Greece, 2015
- *HHMI Science Meeting*, JRC, HHMI, 2015
- *Princeton Neuroscience Institute Seminar*, Princeton University, Princeton, NJ, 2015
- *Swartz Theoretical Neurobiology Seminar*, Yale University, New Haven, CT, 2016
- *Bodian Seminar*, Krieger Mind/Brain Institute, Johns Hopkins University, Baltimore, MD, 2016
- *Department of Neurobiology Seminar*, Harvard Medical School, Boston, MA, 2016
- *Fly Club Seminar*, Duke University, Durham, NC, 2016
- *Distinguished Speaker Seminar*, Max Planck Institute for Neurobiology, Martinsried, Germany, 2016
- *International Titisee Conference on Building Tools for Quantifying Brain and Behaviour*, Titisee, Germany, 2016
- *Simons Foundation Conference on Theory and Biology*, New York City, NY, 2016
- *Center for Integrative Neuroscience and Neuroengineering Seminar*, University of Chicago, Chicago, IL, 2016
- *1st Interdisciplinary Navigation Symposium*, Bad Gastein, Austria, 2016
- *The Kavli Prize Neuroscience Symposia*, Norwegian University of Science & Technology, Trondheim, Norway 2016
- *Hans-Lukas Teuber Lecture*, Department of Brain & Cognitive Sciences, MIT, Cambridge, MA, 2016
- *IMPRS Lecture*, Max Planck Florida Institute for Neuroscience & Florida Atlantic University, Jupiter, FL, 2017
- *Caltech CNS 30th anniversary celebrations*, California Institute of Technology, Pasadena, CA, 2017
- *Champalimaud Colloquium*, Champalimaud Neuroscience Program, Lisbon, Portugal, 2017
- *Neurosciences Graduate Program Seminar*, University of California, San Diego, CA, 2017
- *Computational and Systems Neuroscience (COSYNE) main meeting*, Denver, CO, 2018
- *Computational and Systems Neuroscience (COSYNE) workshop on the Circuit Dynamics of Working Memory*, Breckenridge, CO, 2018
- *Molecular & Cellular Biology Departmental Seminar*, Harvard University, Cambridge, MA, 2018
- *Departmental Seminar*, University of Cologne, Cologne, Germany, 2018
- *HHMI Science Meeting*, JRC, HHMI, 2018
- *Bernstein Conference/ Satellite Workshop on Deciphering neural circuits for innate behaviors*, Berlin, Germany, 2018
- *Bernstein Conference main meeting*, Berlin, Germany, 2018
- *Neuroscience Seminar*, Freie University, Berlin, Germany, 2018
- *GTNeuro Seminar*, Georgia Tech, Atlanta, GA, 2018
- *Neuroscience Seminar Series*, National Institutes of Health, Bethesda, MD, 2018
- *Neuroscience Seminar*, National Centre for Biological Sciences (NCBS), Bangalore, Karnataka, 2018
- *Neurobiology Seminar*, Duke University, Durham, NC, 2019
- *Invariance and Geometry in Sensation, Action and Cognition Workshop*, Harvard University, Cambridge, MA, 2019
- *Neuroscience Seminar*, University of Washington, Seattle, WA, 2019
- *Neuroscience Seminar*, Fred Hutchinson Cancer Research Center, Seattle, WA, 2019
- *The Assembly and Function of Neuronal Circuits*, Ascona, Switzerland, 2019
- *India Science Fest*, Pune, India, 2020

Invited lectures/lecture series

- Neuronal dynamics in the olfactory system. *Experimental & Computational Neurodynamics Summer School*, Center for Theoretical Biological Physics, UC San Diego, CA, 2005.
- Olfactory processing: population dynamics. *IGC Integrative Course*. Gulbenkian Institute, Portugal, 2008.
- Fundamentals of electrophysiology & imaging. *EMBO Global Exchange Lecture Course on 'Systems neuroscience of the Drosophila larva: genetic and circuit bases of behavior'*. National Center for Biological Sciences (NCBS), Bangalore, India, 2010.
- Combining physiology, behavior and optogenetics for Drosophila systems neuroscience. *Causal neuroscience: Interacting with neural circuits*. FENS-IBRO SfN School, Bertinoro, Italy, 2011.
- A peek into the fly systems neuroscientist's toolkit: studying sensorimotor integration in *Drosophila*. *Causal neuroscience: Interacting with neural circuits*. FENS-IBRO SfN School, Bertinoro, Italy, 2013.
- Sensorimotor integration in the central complex. *CSHL Neurobiology of Drosophila: Genes, Circuits and Behavior*, Cold Spring Harbor Labs, NY, 2016
- Abstract internal representations & attractor dynamics in a small brain. *Mathematics of Memory Symposia*, Centre de Recerca Matemàtica, Barcelona, Spain, 2017
- Abstract internal representations and attractor dynamics in the fly brain. *CSHL Neurobiology of Drosophila: Genes, Circuits and Behavior*, Cold Spring Harbor Labs, NY, 2017
- Navigational attractor dynamics in Drosophila: Going from models to mechanism. *FENS-Hertie Winter School on Navigation*, Obergurgl, Austria 2017
- Towards a mechanistic dissection of navigational neural dynamics in *Drosophila*. *CSHL Neurobiology of Drosophila: Genes, Circuits and Behavior*, Cold Spring Harbor Labs, NY, 2018
- Towards a mechanistic understanding of neural dynamics and internal representations in navigation. *Program on Neural computations for sensory navigation*, Kavli Institute of Theoretical Physics, University of California, Santa Barbara, CA, 2018
- How the fly generates a flexible internal representation of heading. *Program on Recording, analyzing, manipulating, and modeling whole brain activity*. Kavli Institute of Theoretical Physics, University of California, Santa Barbara, CA, 2018
- Abstract internal representations and attractor dynamics in the fly brain. *CSHL Neurobiology of Drosophila: Genes, Circuits and Behavior*, Cold Spring Harbor Labs, NY, 2019.

Professional Activities/Organizations

- Reviewer: *European Research Council; Wellcome Trust; Human Frontiers in Science Program (HFSP); National Institutes of Health, National Science Foundation, German-Israeli Foundation for Scientific Research and Development; Agence Nationale de la Recherche (ANR) Blue-Sky Programme, France; The Leverhulme Trust; Boehringer Ingelheim Fonds/ Austrian Science Fund; Knut and Alice Wallenberg Foundation*
- Ad hoc reviewer: *Neuron, eLife, Nature, Science, Nature Neuroscience, Current Biology, Journal of Neuroscience, Nature Methods, Journal of Neurophysiology, Journal of Experimental Biology, Journal of Neuroscience Methods, Nature Protocols, Journal of Computational Neuroscience, PLOS, Frontiers in Neuroscience, Cell Reports*
- Co-organizer: *Using in vivo physiology to understand neural circuits in genetic model organisms* conference, JFRC, HHMI, April 20th-23rd 2008
- Member: Program Committee, *Computational and Systems Neuroscience (COSYNE) meeting*, Salt Lake City,

2009, 2010, 2013, 2014

- Co-organizer: *Technical Challenges in Extracellular Electrophysiology* workshop, JFRC, HHMI, June 14th-16th 2009
- Co-organizer: *Bottom-up and top-down approaches to understanding neural circuits: Meeting in the middle* conference, JFRC, HHMI, Oct 3rd-6th 2010
- Co-organizer: *Towards a common framework to study the function of the insect central complex*, JFRC, HHMI, Apr 15th-18th 2012
- Co-organizer: *How to read a map: Understanding structure-function relationships in the brain*, JFRC, HHMI, Apr 6th-9th 2014
- Co-organizer: *Central Complex IV: A new hope to understand a multifaceted brain region*, JRC, HHMI, Mar 20th-23rd 2016
- Co-organizer: *Structure and function of the insect central complex*, JRC, HHMI, Oct 28th-31st 2018
- Co-organizer: *Junior Scientist Workshop on Neural Circuits & Behavior*. JRC, HHMI, Oct 3rd-8th 2016
- Co-organizer: *Junior Scientist Workshop on Neural Circuits & Behavior*. JRC, HHMI, Oct 1st-6th 2017
- Co-organizer: *Junior Scientist Workshop on Mechanistic Cognitive Neuroscience*. JRC, HHMI, Oct 21st-26th 2018
- Co-organizer: *Junior Scientist Workshop on Mechanistic Cognitive Neuroscience*. JRC, HHMI, Oct 28st-November 1st 2019
- Member: Society for Neuroscience, International Society for Neuroethology